

Concrete Roads



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1914

Laying Concrete on the First Stretch
of the Lincoln Highway in Illinois.

MOOSEHEART
NEAR
AURORA
ILL.



The Beginning of a National Highway with Concrete

Concrete — Roads —

National Pike to be Paved with Concrete

A SECTION of the National Pike in Ohio, seventy-five years ago the most traveled road in the country, is soon to be paved with concrete. It is part of the Cumberland Road, nearly 800 miles long, which was planned to run from Cumberland, Md., to St. Louis, Mo. All but the western end of the road was finished, at a cost to the United States Treasury of about \$7,000,000. From Wheeling west, the road was otherwise known as the "Pike" and the stretch

and west were connected during the period from 1820 to 1850 by wagon roads rather than steam lines. The phrase "Come down the Pike" originated when this was true to fact.

With the coming of steam transportation the road fell into disuse. Quicker transportation was possible, and the heavy cost of maintenance of this national thoroughfare was considered an unnecessary expense. Land grants to railroad companies took the place of appropriations



between Wheeling and Columbus is soon to be the scene of active re-construction with concrete.

This country is in its second era of good road building. The first, beginning in 1806, was remarkable for the tremendous amount of work accomplished with a limited knowledge of road building methods and notwithstanding the comparatively unsettled state of the country. Conditions, however, were very different, in that no steam railways existed at that time, and the necessities and luxuries of life, amusement troupes and mail were forced to pass over the roads. The east

for wagon road building and maintenance.

We are now in the midst of another era of road building, greater in magnitude than the first, due to the now settled condition of the country, and the need for adequate transportation between rural communities and towns. A new need, however, soon developed, a need for inter-city traffic, and the building of the Lincoln Highway and the rehabilitation of the National Pike have come into prominence as a result.

From Wheeling to Columbus, 125 miles, the road passes through the counties of Belmont, Guernsey, Muskingum,

U n i v e r s a l - P o r t l a n d - C e m e n t - C o .

Licking and Franklin. The first contract was awarded for the 24-mile stretch between Zanesville and Hebron, Ohio, for which 85,000 barrels of Universal Portland cement have been bought by the contractor, the H. E. Culbertson Co., of Cleveland, with whom are associated Frank L. Shoemaker, contractor, and H. A. Johnston and G. S. Allen of the Globe Construction Co., all of Kalamazoo Michigan. The contract includes not only the pavement, but the construction of new bridges and rebuilding of old, totaling \$436,017. Licking and Muskingum counties bonded themselves in the sums of \$140,000 and \$100,000 respectively. The State Highway Department furnishes \$80,000 and the Federal Government appropriates \$120,000; the latter from a fund of \$500,000, for the advancement of good roads in all the states which have organized highway departments. Due to Ohio's energetic work in highway development, it has secured the shares of several states that have not been so energetic. The total cost of the improvement planned for 1914 will be about \$2,000,000.

The old Pike is a road of historical interest. Thomas Jefferson in 1806 signed the first American Good Roads Bill, passed by the Ninth Congress, which carried with it an appropriation of \$30,000 for the National Highway. This stretch extended from Cumberland, Md., to a point near Wheeling. Subsequent legislation for the Cumberland Road carried total appropriations amounting to \$7,000,000 paid entirely out of the National Treasury. These amounts seem small today, when the 1914 appropriations of states, counties and the National Government total \$25,000,000. Considering the scant population at that time the early figures are startling.

The road was built by the Federal Government, under the supervision of the War Department, and it is the longest straight road ever built by any government in the world. The eastern end averaged in cost from \$9,000 to \$13,000 per mile, which included heavy grading and massive stone bridges.

In eastern Ohio grading was much less and the cost was in the neighborhood of \$3,500 per mile.

Rivers and creeks were spanned by handsome stone bridges and culverts. Many of these now stand as monuments to the ideals of the early road builders. The traffic passing over the National Pike was of great variety and exceedingly heavy, consisting of large broad wheeled wagons with canvas covers, laden with merchandise and drawn by six horses; four-horse coaches for passengers and caravans of live stock. The early wagons were narrow tired but their destructive action was discouraged by the remission of tolls to those using wide tires. Loads ranged from 6,000 to 10,000 pounds. The cost of transportation was heavy. From Cumberland to Wheeling a rate of \$2.25 per cwt. was charged. The passenger charge was 4c per mile.

The Pike is still in fairly good condition when it is considered that practically no attention has been paid to its maintenance since it was turned over to the various states and later to the counties. Yet many of the original stone bridges are well preserved. The class of houses now found along the Pike distinguish it from other roads. They are substantial, many are of stone. Some of the old inns, which were built at intervals of about 15 miles to serve travelers at the end of each day's travel, are still in existence.

The reconstruction of the National Pike presages a new unity between country and city. While it will reach farmers for only a comparatively short distance on either side, yet its influence in bringing into existence similar trunk lines throughout the country will be marked. Motorists will gain the most immediate advantage but all traffic will develop as soon as the facilities are afforded. The old ideals of Henry Clay, for roads connecting every part of the nation, will shortly be realized. It has taken a century to prove their necessity. With the present widespread call for better conditions it need take but a few years to effect their construction.

Concrete — Roads —

"Movies" and Concrete Roads

ROADS are dull, uninteresting things, yet most important.

The way in which roads are built, however, is a most interesting and timely subject and one which can well be made the subject of moving picture films.

The Universal Portland Cement Co. sent a moving picture operator to Wayne County, (Detroit) Mich., two years ago, to make it possible by means of photographs to show engineers, road men and all interested in the building of good concrete roads, the methods of construction prevailing in Wayne County. There is no place better than this to send for pictures. Not one section of the concrete built by the Wayne County Commissioners has been torn up. Some sections are five years old and the methods in use there are practically standard for the country.

These films covered, first, the striking difference in dust conditions existing between macadam and concrete roads. Automobiles traveling at high speed raise no dust on the latter. Second, the films showed the methods of preparing the sub-grade, of bringing in sand, gravel and cement, and finally, the actual construction.

These films have been shown in practically every state in the east and middle west. They have been shown before road meetings, city councils, commercial clubs, and are now available, upon request, for similar meetings.

On Good Roads day in Illinois, April 15, Governor Dunne initiated the first stretch of the Lincoln Highway in Illinois. It is a 1500-foot section of concrete road, connecting Aurora and Geneva, and its construction is being paid for by the Loyal Order of Moose, whose institutional farm lies along this part of the road.

While Governor Dunne was wielding pick and shovel on the road, operators were making moving pictures of the Governor and the crowd. Later they followed him on an inspection of concrete roads at DeKalb. The Universal Portland Cement Co. is having pictures made now of concrete pavements in service in many Illinois, Michigan and Wisconsin cities, to show the excellent benefits afforded, the freedom from dust and the ease with which they are kept clean.

All of these films will shortly be available, as were the films of Wayne County's roads. Those in charge of road meetings who wish to present the advantages of concrete for country and city pavements, are invited to correspond with this company regarding the use of the films.



Concrete Road Construction in Connecticut

AN appreciation of the work being carried on by the Connecticut State Highway Commission may be had from a consideration of the construction and maintenance costs throughout the state during the last two years. Since the legislative appropriation of \$3,000,000 for road work in 1913, \$2,000,000 of which was designated for the construction of trunk lines and \$1,000,000 as a State aid fund, the following concrete roads have been completed:

The Hartford-Saybrook Turnpike, the second concrete state highway was constructed at a total cost of \$1.63 per yard, including grading and culverts. This road is of the one-course type, 16 feet wide, the thickness varying, being 4½ inches at the sides to 6 inches and 7½ inches at the center. Joints consist of 3-ply tar paper spaced transversely at right angles to the center line of the road every 25 feet. A portion of this road

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conforms to a radius of 150 feet on an 8 per cent grade. A 1:2:4 mixture was used, which was composed of screened gravel in conjunction with $\frac{3}{4}$ -inch and $1\frac{1}{4}$ -inch stone. Shoulders consisting of broken stone were laid on both sides of the road. The length is approximately 5,800 feet.



Concrete Pavement in Connecticut

At West Hartford, Park Street, also a one-course road, 14 feet wide and approximately 7,000 feet long was laid at a cost of \$1.58 per yard. The extreme west end of this road, intersecting Farmington Avenue, is widened to approximately 82 feet. At the point of the road, where the illustration shows a mixer placing concrete, the width of the road is about 24 feet wide. Details of construction used on this street were the same as those for the Hartford-Saybrook Turnpike.

The concrete road at Ridgefield, 12 feet wide, 6,680 feet long, 5 inches thick at the sides and 7 inches at the center, having transverse tar paper joints, as described in the above, was laid at a cost of \$1.38 $\frac{3}{4}$ a yard.

From reports at hand the total mileage of improved roads throughout the state, up to the year 1911, amounted to 3,100 miles. Of this amount 973 miles were improved by State aid.

The state appropriation of \$3,000,000 expires September 30, 1915. The automobile license fees collected by the state

aggregate about \$350,000 per year. Very recent information in regard to cement-concrete street pavements, to be constructed during 1914, contemplates work in the following towns:

Bridgeport.....	60,000 yards
Greenwich.....	6 miles
Hartford.....	$\frac{1}{2}$ mile
Wallingford.....	12,000 yards

Michigan Likes Concrete Roads

CONCRETE road construction in Wayne County, Michigan, was in full sway again by May 10, when 500 men went to work grading, rolling, and surfacing some of the connecting lines between the 80 miles of radial roads now already complete. Wayne County's 80 miles have received a greater amount of advertising than any similar mileage of roads in the world, but they are probably of greater importance to modern road building than any other system of roads, as they are representative of a type which is making upkeep charges inconsequential. The fact, that there is one county, where construction with concrete since 1909 has proven eminently successful, has been sufficient reason for many like developments on a smaller scale, which may some day equal in magnitude Wayne County's splendid system of highways.

To finance the present year's work, the commissioners are about to sell bonds to the value of \$334,000. With the funds on hand, the county will spend an amount probably in the neighborhood of half a million.

The first of the Wayne County roads, that on Michigan Avenue, followed construction methods inferior to those built since. The road carries, with marked success, a traffic averaging over 2,000 vehicles per day, including 1,400 touring cars, 250 automobile runabouts, 85 motor trucks and 145 2-horse wagons.

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CONCRETE ROADS

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CONCRETE ROADS will welcome correspondence concerning concrete road "kinks", suggestions for better practice or other points occurring to those having road construction in their charge. It is intended to serve as a medium of expression of the best thought and practice in the field of concrete pavement construction.

FIVE of the most important roads leading out of Chicago are to be improved with concrete, as part of the first year's work under the new Illinois State Aid Law. The cost of the new highways will be about \$12,000 per mile.

NEXT month will see the start of what will probably be the greatest yardage of concrete ever laid in one section in one year. The counties of Milwaukee, Racine and Kenosha will aggregate 48 miles and Sheboygan County 4 miles more, a total of 52 miles of country roads in a radius of a little over 40 miles.

BIDS were opened at Atlantic, Iowa, for 55 blocks of paving, on April 15. Contracts were awarded for the entire yardage to be constructed of concrete. Up to this time Atlantic had had no concrete pavement, but the experience of Sioux City, where there are 22 miles of successful concrete, and many other Iowa cities not far from Atlantic was sufficient argument.

MACADAM is fast losing friends. A new complaint is, that macadam under city conditions often gets too much water. Usually the driver of the sprinkling cart not only sprinkles but floods it. He leaves the roadway muddy so that he will not have to sprinkle it again the same day. So it seems that macadam is either too dusty or too muddy. Either way its life is short.

"**AS** a result of the splendid service Wayne County roads have given for many years, highway commissioners all over the country have shown increased interest in more substantial pavements on main highways, principally of concrete." This statement was made by R. D. Chapin of the Road Commission of the National Automobile Chamber of Commerce, which met during May in New York City.

SIX miles of concrete pavement have been authorized by Sebewaing Township, Michigan, one mile being in the village of Sebewaing. Last year a half mile of concrete pavement was placed in competition with a half-mile of its nearest competitor in price, and the result was so satisfactory that there was no question as to which pavement would be adopted when funds were available. The six miles of concrete are the result of this test.

FARMERS bringing produce to Minneapolis find that the concrete roads starting at the city limits permit heavier loads with far less effort on the part of their teams. A farmer's load, however, is limited by the worst stretch between his farm and the market. Until the entire distance is concreted his load is limited by the poorest section. Farmers will not be satisfied until they have hard, permanent pavements to their door yards.

NEW YORK state has now come to a realization that the specifications under which Wayne County roads have been built are worthy of adoption. The state's new specifications are practically the same as those developed by the Wayne County Commissioners. The mixture is to be approximately 1:1½:3, the pavement is to be 16 feet wide, 5 inches thick at the edges and crowned to 7 inches thick at the center. Work under these standard specifications should bring results equally good with those in Wayne County. Nothing better is needed.

FRED C. SMITH, City Engineer of Sioux City, Iowa, states that the automobilists invariably choose the concrete roads and pavements in preference to all others to negotiate the heavy grades, of which Sioux City has many. One pavement has a grade of 16 per cent. It is not corrugated and no trouble has been experienced. While the pull is heavy, there is no additional load due to jolting and bumping, common to other

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types in which small units make up the pavement surface. When a city continues to use concrete for its street pavements until a total of 22 miles has been built, it is evident that the pavement has proven satisfactory from every standpoint.

A MONTHLY publication is now issued by the Ohio State Highway Department. In a foreword, James R. Marker, State Highway Commissioner, says that its purpose is to arouse interest and enthusiasm in the cause of good roads. A question-box has been included to which queries are invited relating to road construction, and which are to be answered by the Educational Bureau of the Department.

JUNE 15 was named by Governor George W. Clarke as Iowa Good Roads Day. It was expected that those having an interest in good roads would arrange to spend the day, if not in actual road work, at least in discussing the subject and in listening to men who have given it special study.

The State of Iowa, through the work of organizations and individuals, has manifested strong interest in concrete roads.

THERE has been a noticeable tendency in recent years to increase the thickness of concrete foundations for pavements. While the common practice in this country is to construct foundations four to six inches thick, it is interesting to learn that the annual report of the Metropolitan Paving Committee of London provides for a foundation six to nine inches thick and under some conditions twelve inches. In all instances where concrete foundations have been built in England, Canada and in the United States under specifications calling for unusual thickness, the results have been uniformly satisfactory.

STREET cleaning is a constant drain upon the city's treasury. It is necessary that streets be kept in presentable condition and yet on many common types of residence district pavement, cleaning is such an arduous work that a man can take care of not much more than three or four blocks per day. The cost of street cleaning might well be considered in the choice of pavement. It is distinctly a maintenance charge. A ma-

terial such as concrete, slightly crowned, which permits rain to wash the surface, should be more efficient than any of the rougher types.

Macadam and some other pavements have not been accused, as they should, perhaps, of filling sewers with material which washes through with difficulty. In the surface application of tar, or similar products, considerable finds its way to the gutter and eventually to the sewer inlet. Its nature prevents its ready removal by the flushing following rains. Those pavements having a hard surface not subject to rapid wear nor bound together by bituminous materials, such as concrete, should be free from this action. It would seem reasonable to suppose that the sewers would fill up to a less degree, require less cleaning and, therefore, remove an expense which should be charged against the pavement as maintenance.

"Concrete Roads" wishes to learn the attitude of City Engineers and others familiar with the conditions outlined above. If there is actual data existent it should be made available for all. The opinions of those responsible for the building and upkeep of city pavements should prove valuable to those who have not as yet considered this phase of the problem.

PROCEEDINGS of the National Conference on Concrete Road Building are now printed and ready for distribution. They contain the reports of the several committees, and also the Recommended Practice, together with the Standard Specifications, as adopted by the American Concrete Institute.

This book should be valuable for the road engineer and others interested in the subject of concrete road-building. It is fully indexed, so that all of the information is immediately available.

Copies may be obtained by writing the secretary, J. P. Beck, 208 South La Salle Street, Chicago. For more than one copy, a nominal charge will be made of 25 cents each.

Considering that this Conference was devoted exclusively to the subject of concrete roads, the book is unique. The proceedings of other engineering and contracting societies have covered the same subjects but with nothing like the completeness of this. Comprising, as do the discussions, experiences from all over the country, it is of great general interest and value.

C — o n c r e t e — R o a d s —

Edward N. Hines

PARTICULARLY fitting was the choice of Edward N. Hines of Wayne County fame, to call to order the National Conference on Concrete Road Building, held at Chicago last February. It was an acknowledgment of his notable work for concrete roads.



A character study of Mr. Hines reveals a man of broad sympathies and initiative who has the courage of his convictions. It is not our purpose to dwell on his achievements as they are too well known. His name stands among those foremost in the work of good roads, the building of which he has carried to final success.

Concrete Roads Making Friends Rapidly

PRESS clippings from the newspapers all over the country give daily evidence of this. Frequently newspapers print the warmest endorsement of the concrete road. What the editors of the Indianapolis News think of concrete for roads is evident by the following editorial, printed in the issue of April 2:

CONCRETE ROADS

"Ninety property owners of Washington township, according to representations

made by Emsley W. Johnson, are in favor of improving roads in that township with concrete. These property owners wish to have an election called in order that all the property owners affected shall have opportunity to express their desires. A petition filed by Mr. Johnson with the county commissioners is to come up April 20 for special hearing. It is proposed that about thirty miles of highway be improved with concrete $5\frac{1}{2}$ to $7\frac{1}{2}$ inches thick. The total cost is estimated at \$300,000, or \$10,000 a mile. Under the scheme suggested the concrete roads would join improved roads in Center township, in the city of Indianapolis, and would thus afford good road connections between the city and the surrounding farming country.

"The suggestion ought to be considered by every property owner in Marion county, although those in Washington township are the only ones affected by the present plan. Concrete roads are the roads of the future. The day of the gravel road, of the macadam pike, and certainly of the ordinary earth road, is past. It may seem that \$10,000 a mile is a heavy price for the improvement, but it has been shown, notably in Wayne county, Michigan, that the first cost in concrete construction is the principal cost. The burden of expense in gravel and macadam roads is found in the repair work. *Upkeep is reduced to a minimum with concrete roads. A letter from a man in Arkansas, which is printed elsewhere on this page, is pertinent to the good roads discussion. He believes that the improvement of the many trunk roads leading to Indianapolis would develop the markets of the city and enrich the country.

"The increased cost of living and the growing utility and popularity of the motor car have boomed the good roads movement. Among some people this movement has been interpreted as authorizing an appeal for federal aid. We should have good roads by all means, but these roads should be constructed and

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paid for by the people who use them. Washington township could very well put several hundred thousand dollars into concrete roads. Bonds covering a long period could be issued, so as to extend the burden to others who, in time, will use the highways. In all lines of work it pays to build thoroughly. If roads can be built to last for fifty years, instead of two, the better roads should be chosen."

Concrete Road Literature

THE Universal Portland Cement Co., 208 South La Salle Street, Chicago, has published a number of booklets and pamphlets on the construction of concrete roads, pavements and alleys. Copies will be sent to interested persons, free of charge, upon request.

Concrete Pavements, Sidewalks, Curb and Gutter.

Concrete Alley Pavements.

Facts Everyone Should Know About Concrete Roads.

Concrete Pavements, Roads and Alleys in Wisconsin.

Seventh Annual Report of the Board of County Road Commissioners of Wayne County, Michigan.

Recommended Practice and Proposed Standard Specifications for Concrete Highways and Pavements.

Report on Concrete Paving of Citizens' Committee, of Evanston, Illinois.

Synopsis of Important Features of the New Illinois Highway Law.

Concrete Highway Bridges.

Small Concrete Bridges and Culverts.

Concrete Road Work at Mooseheart, Ill.

PARALLELING the Fox River in the extreme eastern portion of Kane County, Illinois, and connecting the towns of Geneva and Aurora, the Lincoln Highway passes "Mooseheart," an industrial farm belonging to the Loyal Order of Moose. Here the Lincoln Highway had its inception in the State of Illinois, on Good Roads day, April 15, 1914.

The Lincoln Highway is a 3,389-mile stretch of road, extending from New York to San Francisco. At Mooseheart the frontage amounts to about 1500 feet and the entire length of this section has been concreted. Proportionately, it is a small part of the National undertaking, but it is of great interest to the people of the state at large.

The new and liberal policy of Illinois in regard to good roads, as exemplified in the new Tice Law, is emphasized by the attitude of the Loyal Order of Moose, which appropriated \$6,000 as its share of the undertaking to insure proper and immediate construction. This sum is much larger than necessary, as later developments have brought out, but represents what should be the attitude of all communities located along this high-



SETTING UP AN EXPANSION JOINT ON THE MOOSEHEART CONCRETE ROAD

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way toward permanent improvements of this character.

The work is being done by the Loyal Order of Moose, R. H. Brandon, Secretary-Treasurer in charge, under the

200 lineal feet, or 400 square yards per day, the cost of labor amounting to approximately 21 cents per yard, including the services of a superintendent.

The preparation of the sub-grade was done at small expense, the labor being largely contributed by the residents of Mooseheart and neighboring towns on Good Roads Day, when work was begun on the grading. Joints protected by steel

plates were placed at intervals of 50 feet, making an angle of about 70 degrees with the



direct supervision of the Illinois State Highway Commission, and according to the proposed Standard Specifications of the American Concrete Institute. The attitude of the Order toward concrete is evinced by the fact that the first permanent roads within the confines of the farm, one section 40 feet wide, and two sections 30 feet wide, are to be built of concrete. Judging the future from the present operations, concrete will be used for the bulk of all road, as well as other constructional work, carried on at Mooseheart.

A batch mixer of the boom type was the center of activities during the course of construction, as the sub-grade had been put in shape some weeks previous. It was surrounded by a gang of twenty-five men. Both mixer and operator were furnished by, and at the expense of, the State, which also supplied the necessary fuel. It may also be added, that the superintendent for this work was furnished by the State Highway Commission, for whose services a per diem charge of \$6.00 is made.

The road is 1500 feet in length and 18 feet wide, totaling 3,000 yards. The work proceeded at an average rate of



Laying Concrete Road at Mooseheart

line of the road, inclined alternately center to right and left. The plates were cut to 19 feet in length, one foot longer than the width of the finished roadway. This length, intercepted between the parallel side forms, determined the above angle. The filler used was $\frac{3}{8}$ -inch Elastite. It was clamped in 4-foot sections between the protection plates and locked to the $3 \times 3 \times \frac{3}{8}$ -inch steel "T" placing bar, by means of a double row of steel pins. The pins operate on eccentric axes, set opposite through the flanges on 20-inch centers.

Following the laying of each section, the surface was finished by means of wood floats and the edges rounded off. The surface was covered evenly with excavated material as soon as the concrete had set. This was wet down and allowed to remain for a period of at least ten days.

Recommended Practice for Concrete Road Building

THE National Conference on Concrete Road Building, held at Chicago last February, had for its purpose, the discussion of the merits of concrete for roads, the best methods of design and construction, and the formulation of a recommended practice.

Discussions by men well qualified to speak on proper construction methods, together with the reports of the several committees, which had studied particular phases of the work prior to the Conference, resulted in a summary of fundamental principles and recommended practice which is given herewith.

FUNDAMENTAL PRINCIPLES

A brief summary printed in the last issue of Concrete Roads is again given.

1. THE AGGREGATES SHOULD BE CLEAN AND HARD.
2. THE SAND SHOULD BE COARSE AND WELL GRADED.
3. A RICH MIXTURE SHOULD BE USED.
4. THE MATERIALS SHOULD BE CORRECTLY PROPORTIONED.
5. THE MATERIALS SHOULD BE THOROUGHLY MIXED.
6. THE INSPECTION SHOULD BE INTELLIGENT AND THOROUGH.
7. WHEN IN DOUBT, REINFORCE THE PAVEMENT.
8. THE SUB-GRADE SHOULD BE OF UNIFORM DENSITY, THOROUGHLY COMPACTED AND DRENCHED WITH WATER IMMEDIATELY BEFORE PLACING CONCRETE.
9. THE CONCRETE SHOULD BE OF A VISCOUS, PLASTIC CONSISTENCY.
10. AFTER PLACING, THE CONCRETE SHOULD IMMEDIATELY BE COVERED AND KEPT MOIST AND NOT OPENED TO TRAFFIC FOR FOUR WEEKS.

DETAILS OF RECOMMENDED PRACTICE

1. GRADING

(a) SLOPES AND GRADES: The grade of the roadway and the side slopes should be determined by an engineer to meet the local conditions.

(b) EXCAVATION OR TREATMENT OF EXISTING ROADWAY: The fundamental requirement of the sub-grade is that it should at all times be of uniform density, so that it will not settle unevenly and cause cracks in the surface of the pavement, and no part of the work is more worthy of intelligent care and painstaking labor than the preparation of the sub-grade; the slight additional cost necessary to insure good results is abundantly justifiable. When the pavement is constructed on virgin soil, care should be taken to remove all soft spots so as to insure a uniform density; and if constructed on an old roadbed, even greater care must be taken in preparing the sub-grade, which is likely to be more compact in the center than at the sides, and consequently there is more danger that the pavement will settle unevenly, causing cracks.

(c) FILLS: Where roadways are constructed over fills, extreme care should be observed to insure the use of proper material in layers of such thickness that they may be thoroughly compacted so that when the fill is completed there will be a minimum of settlement. The fill should be allowed to stand for as long a time as possible so that it will have an opportunity to settle thoroughly before the pavement is placed thereon. In general, the material composing a fill should be deposited in layers not more than one (1) foot in thickness and each layer should be thoroughly wetted and compacted with a roller weighing ten (10) tons.

(d) SUB-GRADE: Before the pavement is laid, care should be taken to bring the

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sub-grade to proper elevation and to see that it is thoroughly compacted; any soft spots or settlements should be filled with a suitable material.

2. DRAINAGE

The drainage of the roadbed of a pavement is of vital importance. If the sub-grade is not well drained, there is danger of unequal settlement after the pavement is laid, causing longitudinal cracks; there is also a possibility that the frost may lift the edges of the pavement and likewise produce cracks. The character of drainage necessary will depend on local conditions. It is recommended that, in general, proper drainage may be secured through lateral ditches. If underground water is present this may be removed through the use of drain tile laid at a suitable depth on either side of the roadway, or on one side with cross drains from the other side. The top of the tile should not be less than three (3) feet below the sub-grade.

3. MATERIALS

(a) PORTLAND CEMENT: The Portland cement should meet the requirements of the Standard Specifications of the American Society for Testing Materials.

(b) AGGREGATES: The Conference is of the opinion that naturally mixed aggregates should not be used without screening and remixing in proper proportions. The quality of the aggregates can usually be materially improved by washing. Aggregates should not contain frost or frozen lumps.

(A) FINE AGGREGATE: Fine aggregate should consist of sand, crushed stone or gravel screenings, graded from fine to coarse and passing when dry a screen of one-quarter inch mesh. It should be preferably of silicious material, hard* and durable, clean, free from dust, loam, vegetable or other deleterious matter.

*No material is suitable which is not approximately as hard as flint or quartz. The Conference recommends that an investigation be made to devise a suitable, simple test for hardness.

In first-class sands, properly graded from fine to coarse, not more than fifteen (15) per cent of the grains will pass a sieve having fifty (50) meshes to the linear inch and not more than two (2) per cent will pass a sieve having one hundred (100) meshes to the linear inch. Fine aggregate should be of such quality that mortar composed of one (1) part Portland cement and three (3) parts fine aggregate, by weight, when made into briquettes, will show a tensile strength at least equal to the strength of a 1:3 mortar of normal consistency made with the same cement and standard Ottawa sand.

Since it is impossible to determine the quality of sand by the usual eye and hand examination, the Conference is of the opinion that their quality should be determined by tests for tensile strength and mechanical analysis.

(B) COARSE AGGREGATE: Coarse aggregate should consist of clean, hard** and durable crushed gravel or stone graded in size, all of which will pass a one and one-half ($1\frac{1}{2}$) and be retained on a one-quarter ($\frac{1}{4}$) inch screen. It should be clean, hard, and durable and free from all deleterious matter, and should not contain flat or elongated particles.

(c) WATER: Water should be clean, free from oil, acid, alkali or vegetable matter.

(d) REINFORCEMENT: All reinforcement shall develop an ultimate tensile strength of not less than 70,000 pounds per square inch and bend 180° around one diameter and straighten without fracture.

All reinforcement should be free from excessive rust, scale, paint or coatings of any character which would tend to reduce or destroy the bond.

**The term "hard" as used here refers to the French co-efficient of wear; the Conference recommends that the material should have a co-efficient of not less than twelve.

For method of determining French co-efficient of wear, see Baker's Roads and Pavements, page 184, Edition of 1913.

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4. FORMS

(a) **MATERIALS:** Forms may be of wood or metal and should be free from warp, of sufficient strength to resist springing out of shape, and have a width equal to the required thickness of the pavement.

(b) **SETTING:** The forms should be well staked and rigidly held in position and their upper edges should conform to the established grades of the pavement. The Conference believes that metal forms are preferable. Where wooden forms are used they should be capped with metal. The forms should be thoroughly cleaned before being used.

5. THICKNESS

The thickness of the concrete pavement is controlled by many factors such as condition and character of the sub-grade, drainage, traffic, climatic conditions, width of pavement, etc. Three distinct types of cross sections are in general use:

1. Uniform thickness of concrete for all widths of roadway and consequently the same amount of crown in the foundation as in the surface.

2. Roadways in which the concrete is thicker at the center than at the edge, but in which some crown is given to the foundation.

3. Concrete roadways in which the concrete is thicker at the middle than at the edge, but which are built upon a flat sub-grade.

The Conference recommends the latter type for all roadways of twenty (20) feet or less in width.

6. WIDTH

The Conference recommends that the minimum width be ten (10) feet for single track roads and eighteen (18) feet for double track roads. For roads eighteen (18) feet or more in width, it is unnecessary to provide turnouts of gravel or macadam shoulders, which greatly increase the cost of maintenance.

7. CROWN

Unlike some types, concrete pavements are not damaged by water. If it were

not for the need for drainage, a perfectly flat road would be preferable because it would lead to a better distribution of the traffic. Since thin sheets of water or ice on the surface of any pavement are objectionable, a slight crown should be provided to insure drainage of the surface, and the Conference is of the opinion that for country highways a crown of one one-hundredth (1-100) of the width is sufficient. Because of the peculiar needs for drainage in cities, a crown of one-seventieth (1-70) of the pavement width will usually be found ample. On steep grades this crown may be correspondingly reduced.

8. JOINTS

(a) **WIDTH AND LOCATION:** It is a well known fact that under ordinary conditions cracks may be expected in plain concrete unless joints are provided at intervals, but such cracks may be prevented or so distributed as to become small and unobjectionable, through the use of sufficient reinforcing steel. Joints are a source of trouble, even if properly spaced and properly constructed and, if possible, should be avoided. These joints necessarily interrupt the continuity of the pavement and are a source of expense in maintenance.

The Conference is of the opinion that where joints are used they should be located at intervals of from 25 to 50 feet, although under favorable conditions longer sections have been successfully used.

While it is the current practice to provide metal protection for the joints, the Conference is of the opinion that later experience may show that a single layer of prepared felt not exceeding one-eighth ($\frac{1}{8}$) of an inch in thickness without metal protection will prove more satisfactory.

(b) **PROTECTION AND FILLER:** The joint is preferably protected by two pieces of metal, having high resistance to abrasion, three (3) inches wide and about three-sixteenths ($\frac{3}{16}$) thick, between which is placed one layer of prepared felt of a width equal to the thickness of the pavement.

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9. REINFORCING

The Conference is of the opinion that all roads exceeding twenty (20) feet in width should preferably be reinforced with some form of metal fabric and recommends that the cross-sectional area of the reinforcing metal running parallel to the center line of the pavement should be about 0.038 square inch per foot of pavement width and of metal running transversely 0.049 square inch per foot of pavement length, the purpose of such reinforcing being to distribute the effect of expansion and contraction due to temperature changes and moisture content of the concrete, as well as the weight of traffic over defects in the sub-grade. The reinforcement should be embedded at least two (2) inches and not more than three (3) inches below the surface of the pavement.

10. MIXING AND PLACING CONCRETE

(a) MEASURING: The method of measuring materials for the concrete, including the water, should be one which will insure correct proportions of each of the ingredients at all times. It is recommended that a sack of Portland cement, containing ninety-four (94) pounds net, be considered the equivalent of one cubic foot.

(b) PROPORTIONS: The Conference recommends that the proportions do not exceed five (5) parts of fine and coarse aggregate to one (1) part of cement, and that the fine aggregate should not exceed forty (40) per cent of the mixture of fine and coarse aggregates.

(c) MIXING: Ingredients of which the concrete is composed should be mixed in a batch mixer of approved type, and the mixing should be continued after all the materials are in the mixer for at least one minute; during the mixing time there should be at least fourteen (14) complete revolutions of the mixer. The Conference is decidedly of the opinion that the durability of a concrete road is largely affected by the proper proportioning and thorough mixing of the ingredients.

(d) CONSISTENCY: The practice is to mix concrete entirely too wet. The consistency should be such as not to require tamping, but not so wet as to cause the separation of the mortar from the aggregate in handling and placing. The concrete, when properly mixed, should have a viscous, plastic consistency.

(e) PLACING: Just before placing the concrete the sub-grade should be brought to its original surface, if it has been disturbed by teaming or other causes, and thoroughly saturated with water. The concrete should be deposited rapidly in successive batches to the required depth and width of the pavement, in a continuous operation. The section should be completed to a transverse joint, without the use of intermediate forms or bulkheads, or a transverse joint may be placed at the point of stopping of the work. In case the mixer breaks down the concrete should be mixed by hand to complete the section.

(f) FINISHING: The surface of the concrete should be struck off by means of a template moved with a combined longitudinal and transverse motion. The excess of material accumulated in front of the template should be uniformly distributed over the surface of the pavement except near the transverse joint, when the excess material should be removed.

The concrete adjoining the transverse joint shall be dense and any depressions in the surface shall be filled with a mortar composed of one (1) part of Portland cement or not more than two (2) parts of fine aggregate. After being brought to the established grade with a template the concrete should be finished, from a suitable bridge, with a wood float to true surface. A metal template should not be used.

(g) RETEMPERING: Retempering of mortar or concrete which has partially hardened, that is, mixing with additional materials or water, is strongly condemned and should not be permitted.

(h) TEMPERATURE BELOW 35° FAHR.: If the temperature during the progress of the work should drop at any time be-

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low thirty-five (35°) degrees Fahrenheit, the water and aggregates should be heated and precaution should be taken to protect the work from freezing for a period of at least ten (10) days. In no case should concrete be deposited when the sub-grade is frozen.

The Conference is of the opinion that under no condition should concrete road construction be carried on during freezing weather.

11. CURING AND PROTECTING

The curing of the exposed surface of concrete is a matter of the greatest importance. Good concrete can be easily destroyed by too rapid drying out or opening it to traffic at too early a period. It is, therefore, highly desirable that the finished pavement should be covered with sand or earth and kept sprinkled for a period of at least fourteen (14) days, the purpose of which being to keep the concrete moist, and to prevent the evaporation of the water which is necessary for the proper hardening of the concrete. Where conditions will permit the Conference would recommend that the concrete pavement be not opened to traffic until after an interval of at least four (4) weeks, during which period it shall be protected as above described.

12. SPECIFICATIONS

Since no specifications were considered by the Conference the Standard Specifications for Pavements and Roadways of the American Concrete Institute are recommended.

Respectfully submitted,

COMMITTEE ON RESOLUTIONS.

RICHARD L. HUMPHREY, Chairman,
President, American Concrete Institute.

IRA O. BAKER, Secretary,
Professor of Civil Engineering, University of Illinois.

W. F. M. GOSS (Ex Officio),
Dean, College of Engineering, University of Illinois.

F. E. TURNEAURE,
Dean, College of Engineering, University of Wisconsin.

A. MARSTON,
Dean and Director, Division of Engineering,
Iowa State College,

A. N. JOHNSON,
Illinois State Highway Engineer.

THOMAS H. MACDONALD,
Iowa State Highway Engineer.

JAMES R. MARKER,
Ohio State Highway Commissioner.

EDWARD N. HINES,
Chairman, Board of County Road Commissioners,
Wayne County, Michigan.

W. K. HATT,
Professor in Charge, School of Civil Engineering,
Purdue University.

J. T. VOSHALL,
Senior Highway Engineer, United States Office
of Public Roads.

SANFORD E. THOMPSON,
Consulting Engineer.

F. P. WILSON,
City Engineer, Mason City, Iowa.

LEONARD S. SMITH,
In Charge of Roads and Pavements, University
of Wisconsin.

C. W. BOYNTON,
Inspecting Engineer, Universal Portland Cement Co.

ROBERT SWAN, Director of Public Service, city of Pittsburgh, stated at a meeting of the Builders Exchange that the city had written specifications and would shortly build concrete streets and alleys, and that if they were as successful as he had every reason to believe they would be, they would build a great many streets in the near future.

BEMIDJI, Minnesota, was one of the earliest cities to use concrete for city pavements. Each year has seen some additional work. This year 40,000 square yards of concrete are planned.

A SHORT time ago there was laid in front of the Proctor Building, designed as a social center for Peoria, Illinois, a block of concrete street pavement. So pleased were the property owners with the improvement that a petition is now being circulated for four blocks more of concrete.

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1914	19,200,000 SQ. YDS.
1913	10,100,000 SQ. YDS.
1912	6,470,000 SQ. YDS.
1911	1,800,000 SQ. YDS.
1910	850,000 SQ. YDS.
1909	364,000 SQ. YDS.

Yearly Yardage Concrete Pavements Increasing

THE following diagram gives the approximate annual yardage of concrete pavements laid in the United States from 1909 to 1913 and the probable quantity for 1914. For two years the increase was about four million square yards per year. More than double this increase, and triple the 1912 yardage, is probable in 1914.

Such increased use is significant of a new and broad interest in concrete, a recognition of its excellent service and a better understanding of construction methods.

Road Meeting Dates

ARRANGEMENTS are being perfected by the American Highway Association, in conjunction with the American Automobile Association, to hold the FOURTH AMERICAN ROAD CONGRESS at Atlanta, November 9-13. The American Bar and American Bankers' Associations will be represented. The county commissioners of Georgia recently perfected a new organization, and they

intend to hold their first annual meeting at this time. Further information desired may be secured from the American Highway Association, 708 Colorado Building, Washington, D. C.

DECEMBER 14 to 17, 1914, marks the date of the FIFTH AMERICAN GOOD ROADS CONGRESS at Chicago. In conjunction with this meeting the American Road Builders' Association will hold its Eleventh Annual Convention, together with the Sixth Annual Exhibition of Machinery and Materials. Meetings are to be held in the International Amphitheatre at the Union Stock Yards.

Further information may be had by writing the Secretary, E. L. Powers, 150 Nassau Street, New York.

MILWAUKEE County has recently achieved renown because of its excellent concrete roads. It is proper that the NORTHWESTERN ROAD CONGRESS, which was organized at the Hotel Pfister, Milwaukee, April 20, should hold its first convention in Milwaukee, October 28 to 31, 1914, giving delegates an opportunity to inspect the new county work. There are over 30 miles of concrete highway completed and much under way.



Blue Mound Road, one of Milwaukee County's Splendid Concrete Highways

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